AIR FORCE

QUALIFICATION TRAINING PACKAGE (AFQTP)

FOR

ELECTRICAL POWER PRODUCTION

(3E0X2)

MODULE 13

ELECTRICAL POWER PRODUCTION TOOLS AND TEST EQUIPMENT

TABLE OF CONTENTS

MODULE 13

ELECTRICAL POWER PRODUCTION TOOLS AND TEST EQUIPMENT

Career Field Education and Training Plan (CFETP) references from 1 Aug 02 version.

OPR: HQ AFCESA/CEOF
(SMSgt Michael A. Trevino)
Supersedes AFQTP 3E0X2-12, 15 Aug 00

Certified by: HQ AFCESA/CEOF
(CMSgt Myrl F. Kibbe)
Pages: 15/Distribution F

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ELECTRICAL POWER PRODUCTION

(3E0X2)

INTRODUCTION

Before starting this AFQTP, refer to and read the "AFQTP Trainer/Trainee Guide."

AFQTPs are mandatory and must be completed to fulfill task knowledge requirements on core and diamond tasks for upgrade training. ***It is important for the trainer and trainee to understand*** that an AFQTP ***does not*** replace hands-on training, nor will completion of an AFQTP meet the requirement for core task certification. AFQTPs will be used in conjunction with applicable technical references and hands-on training.

AFQTPs and Certification and Testing (CerTest) must be used as minimum upgrade requirements for Diamond tasks.

MANDATORY minimum upgrade requirements:

Core task:
AFQTP completion
Hands-on certification

Diamond task:
AFQTP completion
CerTest completion (80% minimum to pass)

Note: *Trainees will receive hands-on certification training for Diamond Tasks when equipment becomes available either at home station or at a TDY location*.

Put this package to use. Subject matter experts under the direction and guidance of HQ AFCESA/CEOF revised this AFQTP. If you have any recommendations for improving this document, please contact the Electrical Power Production Career Field Manager at the address below.

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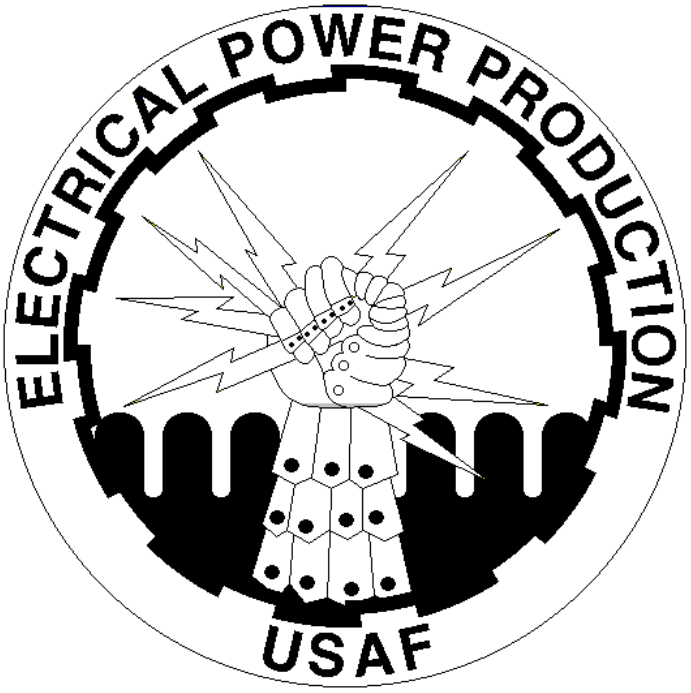

ELECTRICAL POWER PRODUCTION TOOLS AND TEST EQUIPMENT

USE ELECTRICAL TEST EQUIPMENT

MODULE 13 **AFQTP UNIT 5**

MULTIMETER (13.5.1.)

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USE MULTIMETER

Task Training Guide

STS Reference Number/Title:	13.5.1., Use electrical test equipment, multimeter.
Training References:	1. Applicable Multimeter Manufacturer Manuals. 2. Career Development Course (CDC) 3E052A Vol. 2, Unit 4: *Electrical Fundamentals and Troubleshooting.* 3. CD-ROM Air Force Qualification Training Package (AFQTP) 3E0X2 Electrical Power Production Version 1.0, Mar 99: *Power Production Test Equipment.*
Prerequisites:	1. **Possess as a minimum a 3E032 AFSC.** 2. **Review the following references:** 2.1. Applicable Multimeter Manufacturer Manuals. 2.2. CDC 3E052A Vol. 2, Unit 4: *Electrical Fundamentals and Troubleshooting.* 3. **Complete CD-ROM AFQTP 3E0X2 Electrical Power Production Version 1, Mar 99: *Power Production Test Equipment.***
Equipment/Tools Required:	1. Computer to support AFQTP CD-ROM. 2. Multimeter. 3. Battery. 4. Standard wall outlet or suitable 120 VAC or just AC power source. 5. Standard single pole switch.
Learning Objective:	Proper application and functions of a multimeter.
Samples of Behavior:	Trainee will be able to determine when and how to use a multimeter.
Notes:	
1. Any safety violation will result in failure. 2. Trainer will demonstrate and test trainee on various applications to insure safe operations.	

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USE MULTIMETER

1. Background: There are many different types of electrical meters; all of them are important tools for the maintenance and troubleshooting of electrical equipment and circuits. The construction features may vary slightly for different brands of meters but the theory of operation is essentially the same. For example all analog multimeters consist of a meter coil, a means of selecting a function, (A/C, D/C, Mil Amp, and so forth), a means of selecting the range or scale of measurement (0.5to 1000), and a scale which shows the value of measurement. Digital meters operate in the same basic manner. We need to understand their uses and differences to ensure we interpret their readings correctly to be effective with our mission. Many accidents occur while taking meter readings resulting in personal injury or equipment damage, therefore we must understand the operation and ensure all safety procedures are followed. The ability to select the correct type of electrical meter for the application required is no easy task without proper training. Serious injury or death can result from improper meter selection and use. It is imperative we perform with confidence and safety at all times.

2. *Complete the CD-ROM AFQTP 3E0X2 Electrical Power Production, Version 1.0, Mar 99: Power Production Test Equipment. Upon completion of the above-mentioned CD-ROM properly use a multimeter following the step-by-step procedures listed below.*

NOTE:
The review questions for this material are contained in the above–mentioned CD-ROM.

TRAINER NOTE:
Your equipment may vary. Use this as a teaching guide to insure trainee can successfully operate all meters utilized in your work section.

SAFETY:

1. BEFORE USING ANY METER BE SURE TO:

1.1. REMOVE ALL JEWELRY.

1.2. NOT EXCEED METER SPECIFICATIONS DURING ANY TEST (REFER TO APPLICABLE MANUFACTURER MANUAL).

1.3. ENSURE CIRCUIT IS DE-ENERGIZED WHEN USING THE OHM/CONTINUNITY FUNCTIONS.

NOTE:
To accomplish task we have selected a battery to test for direct current, wall outlet for alternating current, and a single pole switch to check resistance/continuity (ohms).

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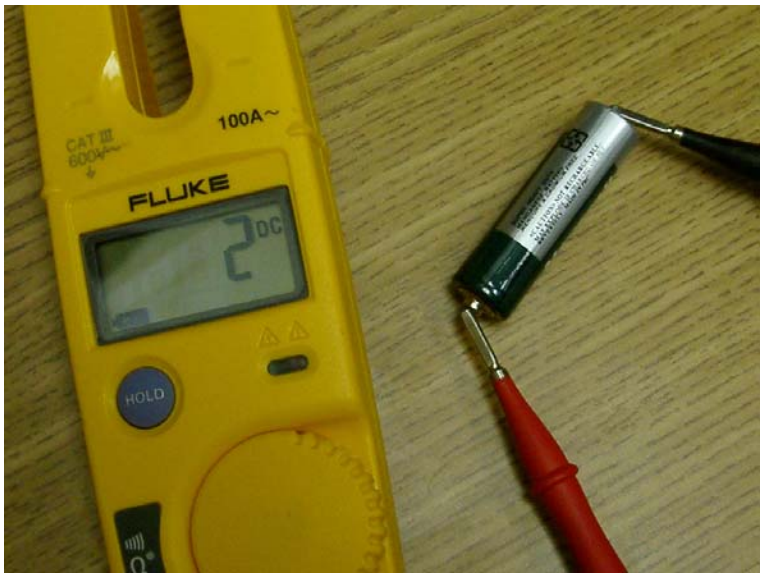
3. USING MULTIMETER TO CHECK VOLTAGE, DIRECT CURRENT (VDC).

3.1. ***To perform this task utilizing a battery, follow these steps:***



Multimeter- Checking Voltage, Direct Current (VDC)

Step 1: Set-up multimeter for proper operation in accordance with applicable technical reference.

Step 2: Connect meter leads to the battery.

Step 3: Interpret the voltage reading on the meter.

Step 4: Disconnect meter leads from the battery.

Step 5: Turn off the meter.

4. USING MULTIMETER TO CHECK VOLTAGE, ALTERNATING CURRENT (VAC).

4.1. ***To perform this task utilizing a standard wall outlet or other VAC source, follow these steps:***

SAFETY:

1. **FOLLOW APPLICAPLE MANUFACTURER'S MANUAL INSTRUCTIONS REGARDING THE VOLTAGE LIMITATIONS OF THE METER.**
2. **SERIOUS INJURY OR EQUIPMENT DAMAGE COULD RESULT IF METER LIMITATIONS ARE EXCEEDED.**

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Multimeter- Testing for Voltage Alternating Current (VAC)

Step 1: Set-up multimeter for proper operation in accordance with applicable technical reference.

Step 2: Connect meter leads to the VAC power source.

Step 3: Interpret the voltage reading on the meter.

Step 4: Disconnect meter leads.

Step 5: Turn off the multimeter.

NOTE:
Keep in mind the words ***"Difference of Potential."*** Difference means subtraction in basic mathematics. You have 130 volts on one of the leads and 0 volts on the other therefore:
130-0=130

5. USING MULTIMETER TO CHECK RESISTANCE/CONTINUITY (OHMS).

5.1. *To perform this task utilizing a single pole switch, follow these steps:*

SAFETY:
SERIOUS INJURY AND/OR EQUIPMENT DAMAGE COULD RESULT IF THE SWITCH IS NOT DE-ENERGIZED AND ISOLATED FROM ALL POWER SOURCES.

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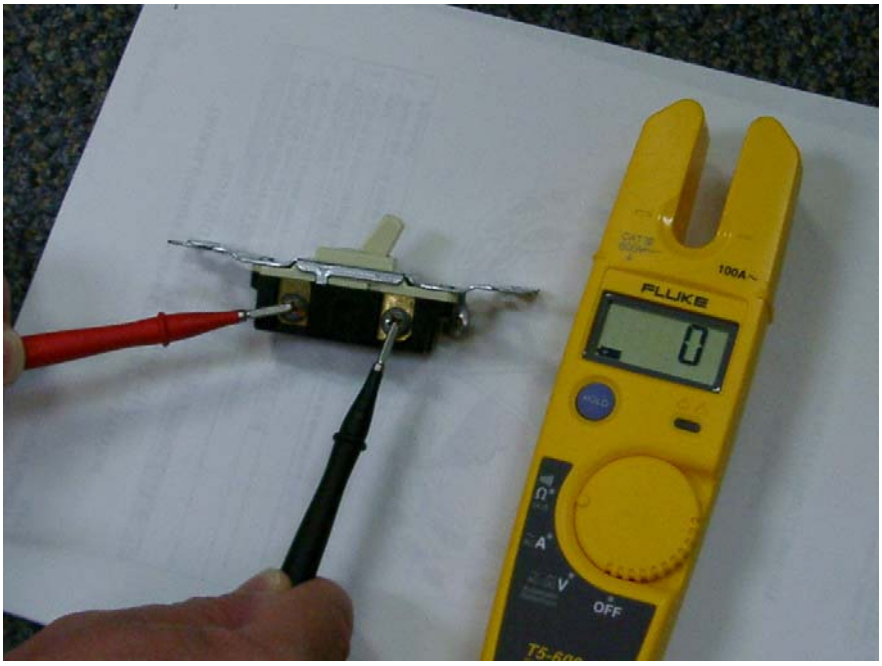

Multimeter- Checking Resistance Switch ON (closed)

Step 1: Set-up multimeter for proper operation in accordance with applicable technical reference.

Step 2: Place the Switch in the ON position. Connect one of the meter leads to the one of the poles on the switch.

Step 3: Connect the other meter lead to the other pole on the switch.

Step 4: Interpret the reading on the meter.

NOTE:
Resistance is the opposition of current flow. With the switch on (closed) there is a complete path for current to flow through the switch giving a very low resistance reading on the meter.

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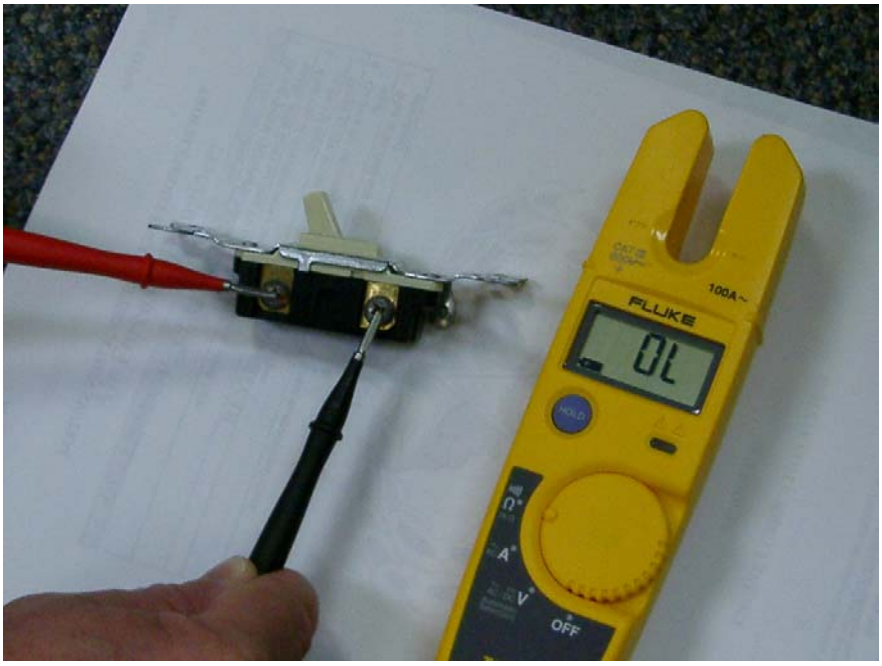

Multimeter- Checking Resistance Switch OFF (open)

Step 5: Place the switch in the OFF position.

Step 6: Interpret the reading on the meter.

Step 7: Disconnect the leads.

Step 8: Turn off the multimeter.

NOTE:

With the switch in the off position (open), there is a very high amount of resistance to current flow. So much resistance the meter cannot read it. The typical Fluke meter will give you the reading of OL on the display. This simply means the reading is beyond the range of the meter. Why do we use the resistance function only when the circuit is de-energized? One very important reason is because the meter is using its own internal power source (battery) to send current through the wires. If the circuit is energized, there is a good possibility for meter damage and incorrect readings.

6. Checking for Opens in Low Voltage Energized Circuit.

SAFETY:

FOLLOW APPLICAPLE MANUFACTURER'S MANUAL INSTRUCTIONS REGARDING THE VOLTAGE LIMITATIONS OF THE METER. SERIOUS INJURY OR EQUIPMENT DAMAGE COULD RESULT IF METER LIMITATIONS ARE EXCEEDED.

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6.1. What do you do if it is impossible, or impractical, to de-energize the electrical circuit and need to troubleshoot for some mystery fault? One good example of this need would be when dealing with Automatic Transfer Panels. It is always best to de-energize whenever possible. Great care must be taken not too exceed the limitations of the meter, injure yourself, and/or damage the equipment when working on energized circuits. When referring to low voltage we are talking about voltages less than 600 volts. It is imperative to check the design limitations of the meter and consider the proper tools and safety gear needed to work on any energized equipment.

6.2. In order to check for opens we will have to utilize the VAC setting on the meter. We will be looking for a difference of potential from one end of a wire to another or from one side of a closed switch to the other. Remember the words used to describe voltage: Difference of Potential.

6.3. If there is no open the reading on the meter should be very close to 0 volts. In a 120 volts circuit this simply means there is 120 volts at both leads (120-120=0).

6.4. If there is an open the reading on the meter should read above 0 volts. In the case depicted in the pictures below the reading across the open switch is 135 volts. There is 130 volts on one side and 0 volts on the other (135-0=135). It will not always be the applied power source voltage reading (I.E: 120 VAC). Electricity will go anywhere is can until something gets in its way similar to water running down a hill. There maybe alternate paths the electrical power can take to get through the circuit such as transformers and terminal board junctions. The reading you get should be very close to 0 VAC if the circuit is closed. This is what is important. Any reading above 0 VAC should be investigated further. It may be a good idea to de-energize the circuit and check again with the Resistance function.

6.5. USING MULTIMETER TO CHECK OPENS UTILIZING VAC FUNCTION

6.5.1. ***To perform this task utilizing a energized single pole light switch, follow these steps:***

SAFETY:

SERIOUS INJURY AND/OR EQUIPMENT DAMAGE COULD RESULT IF CAUTION IS NOT TAKEN IN THIS PROCEDURE. EVERY EFFORT SHOULD BE MADE TO PERFORM THIS TASK AS SAFELY AS POSSIBLE.

Multimeter- Checking VAC across Closed (ON) switch

Step 1: De-energize switch circuit and follow all procedures for tagging-out circuit.

Step 2: Remove switch face cover.

Step 3: Loosen the two screws holding the switch into the box until you can safely reach the two side terminals without interference.

Step 4: Place the switch in the ON position (closed).

Step 5: Energize the circuit (Be Careful!)

Step 6: Turn the multimeter on.

Step 7: Set the multimeter to the VAC function.

Step 8: Connect one lead to one terminal.

Step 9: Connect the remaining lead to the other terminal.

Step 10: Interpret the reading on the meter.

Step 11: Disconnect the meter leads.

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Multimeter-Checking VAC Across Open (OFF) switch

Step 12: Carefully place the switch in the OFF position (Open).

Step 13: Reconnect the leads and interpret the meter reading.

Step 14: Disconnect the leads and turn off the multimeter.

Step 15: De-energize the power to the light switch.

Step 16: Re-assemble the light switch to include replacing the cover.

Step 17: Energize the power to the light switch.

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USE MULTIMETER

PERFORMANCE CHECKLIST

INSTRUCTIONS:

The trainee must satisfactorily perform all parts of the task without assistance. Evaluate the trainee's performance using this checklist.

DID THE TRAINEE….?	YES	NO
1. Describe the different functions of a multi-meter		
2. Properly set-up the multimeter for checking: 2.1. Voltage, Direct Current (VDC) 2.2. Voltage, Alternating Current (VAC) 2.3. Resistance/Continuity (Ohms)		
3. Properly connected meter to the circuit to be tested (Proper polarity of leads when testing VDC.)		
4. Properly interpret the indicated meter reading		
5. De-energize and isolate the circuit when testing for resistance and continuity (Ohms) (Ref. to questions 1,2, & 4)		
6. Follow all safety procedures		

FEEDBACK: Trainer should provide both positive and/or negative feedback to the trainee immediately after the task is performed. This will ensure the issue is still fresh in the mind of both the trainee and trainer.

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MEMORANDUM FOR HQ AFCESA/CEOF
139 Barnes Drive Suite 1
Tyndall AFB, FL 32403-5319

FROM:

SUBJECT: Qualification Training Package Improvement

1. Identify module.

   Module # and title_____

2. Identify improvement/correction section(s):

   _____ STS Task Reference
   _____ Training Reference
   _____ Evaluation Instructions
   _____ Performance Resources
   _____ Steps in Task Performance
   _____ Performance Checklist
   _____ Feedback
   _____ Format
   _____ Other

3. Recommended changes--use a continuation sheet if necessary.

   _____
   _____
   _____
   _____
   _____
   _____
   _____
   _____

4. You may choose to call in your recommendations to DSN 523-6392 or FAX DSN/Commercial 523-6488 or (850) 283-6488 or email ceof.helpdesk@tyndall.af.mil.

5. Thank you for your time and interest.

YOUR NAME, RANK, USAF
Title/Position